MCNEIL RIVER STATE GAME SANCTUARY PERMIT LOTTERY APPLICANT PREFERENCES and MARGINAL WILLINGNESS TO PAY FOR PERMIT APPLICATION: A BEST-WORST DISCRETE CHOICE EXPERIMENT

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ABSTRACT

This study applies data from a web-based survey administered to 2016-2018 McNeil River State Game Sanctuary permit lottery applicants to examine preferences and marginal willingness-to-pay (WTP) for an application contingent upon marginal interval increases among specific attributes of a bear viewing experience. A best-worst discrete choice experiment (BWDCE) was used to elicit respondent data, which consisted of eight individual choice tasks using a Balanced Incomplete Block Design (BIBD) in Sawtooth Software. Each choice task was comprised of five attributes: permit application price, odds of winning a permit, number of bears viewed daily during visit to the Sanctuary, cubs being present, and most common type of bear feeding activity viewed while at the Sanctuary. Each attribute was decomposed into two to four varying levels across choice tasks, depending on the attribute in question. The findings suggest that lottery permit applicants have a significant desire to view bears fishing for salmon, and to see cubs. These results imply a clear desire of applicants to visit the Sanctuary in high season. As expected, respondents also stand to obtain a positive effect on personal utility of increased odds of winning a permit, and to a lesser extent, view a larger number of bears while at the Sanctuary, and therefore have a positive mWTP to both of these characteristics as well. The price coefficient in both the preference parameter utility model and the mWTP model is negative, as expected, but not large in magnitude which may be attributed to the sample being wealthier than average and/or the forgone permit application price is viewed as a wildlife conservation donation. The main model used for analysis is the mixed (random parameters) logit (MXL), and the preference parameters estimated are then used to estimate mWTP in WTP-space using Stata. Results using a multinomial logit (MNL) and conditional logit (CL) are also presented for comparison and affirmation that MXL is better suited for the data in order to allow for preference heterogeneity and random parameters, rather than fixed parameters.

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INTRODUCTION

Visitors from around the world come to Alaska each year to experience the beauty of the State's remote wilderness and wildlife. The Center for Economic Development (CED) estimates that consumer spending on wildlife viewing in 2017 supported $1 Billion in wages and 28,000 jobs for employees in Alaska [1]. While there are many types of wildlife that visitors come to view, coastal brown bear (ursos arctos) viewing in particular is a unique experience because the bear concentrations are the largest found anywhere in the world. This phenomenon makes it an extremely popular destination activity in the State, and is generally attributed to the annual salmon runs that Alaska experiences each summer [2].

One of the major bear viewing sites in Alaska is the McNeil River State Game Sanctuary (SGS), managed by the Alaska Department of Fish & Game (ADF&G) [2]. Katmai National Park & Preserve (NP&P) and Lake Clark National Park & Preserve (NP&P) also offer bear viewing opportunities. However, these federally managed parks have no visitation restrictions and therefore can be extremely crowded during peak season, especially Katmai NP&P [3, 4]. The experience at McNeil River SGS is unique due to the permit lottery system regulating visitation to the Sanctuary. The regulations, administered by ADF&G, are designed to allow for an intimate bear viewing experience while preserving the bears' natural environment with little to no human impact [2].

Best-Worst Discrete Choice Experiments (BWDCEs) are most commonly applied to healthcare research [6, 12, 13], but has been spreading across a number of research fields in recent years including environmental services valuation [10, 11], restaurant services in Australia [16], and even wine preferences in Spain [14]. Best-Worst Scaling (BWS) is based on the random utility theory in economics and psychology [16]. BWDCEs are a specific type of BWS method that uses a choice modelling experimental procedure, requiring specific attributes to be identified in terms of a particular magnitude along a continuum, such as odds of winning a lottery (0-100%). BWDCEs additionally require each identified attribute to be further broken down into specific levels that lie along the continuum identified [16].

"The BWS method effectively permits respondents to evaluate all pairwise combinations of alternatives presented in a particular subset leading to the assumption that their "best" and "worst" choices represent the maximum different in utility between all attributes" [16]. This assumption follows that the BWS method has been found to produce the most robust and reliable data, allowing researchers to develop and discern consumer preferences to the highest degree possible comparative to other possible methods, such as the use of a Likert scale.[1] A notable reason for this is that respondents are able to fully comprehend each level in a BWDCE, in comparison to rating scales and ranking tasks which often involve vague scaling differences, causing asymmetrical interpretation among respondents [16].

The McNeil River SGS bear viewing permit lottery was chosen as the focus of our BWDCE due to the unique requirement of bear viewing participants to obtain a visitation permit, which costs Alaskan residents $225 and non-residents $525 per person not including the permit application cost (currently $30) [2]. These costs are in addition to all costs associated with remote backcountry camping in Alaska including but not limited to commercial flights to/from the State, charter flights to/from the bear viewing site, food and water, and required recreation equipment such as hip waders. Visitors to Katmai NP&P and Lake Clark NP&P incur all of the above costs except for the permit, which is not only required to visit McNeil River SGS, but is allocated through a lottery in which the average odds of winning range from 2% to 20%, dependent on the time block an applicant applies for [2]. In order

[1] A Likert scale is an ordered scale presented to respondents in order to elicit the one particular option that best aligns with their opinion or view. A common Likert scale that is used in much of industry management literature asks respondents to indicate to which degree they agree or disagree with a particular statement, e.g. "Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree" [7].

to gain direct insight as to why applicants would like to visit McNeil River SGS as opposed to one of the National Parks for bear viewing, we included a multiple-choice question (no open-ended option) that asked: "What was the most important factor when deciding to apply for the McNeil River State Game Sanctuary permit to go bear viewing (rather than visiting "open-access" areas in Katmai National Park & Preserve or Lake Clark National Park & Preserve)?" Of the 224 total respondents, 94 (42%) indicated "less human interaction" or "more personalized experience" as their answer, while 85 (38%) indicated "higher concentration of bears to see", and 36 (16%) answered "highly suggested by a friend or relative".

The purpose of the following analysis is to elicit the relative preference, or value, of each identified attribute associated with bear viewing at McNeil River SGS, and to explicitly determine their marginal willingness-to-pay (mWTP) for a permit application dependent upon specific attribute levels associated with bear viewing. The first section discusses the basic background of the uniqueness of brown bear viewing at McNeil River SGS and the structure of the permit lottery. The second section reviews associated literature of previous McNeil River SGS visitor welfare estimates and a general overview of Best-Worst Scaling (BWS). The third section extends this overview, specifically detailing the structure of a Best-Worst Discrete Choice Experiment (BWDCE), which is the method used in the subsequent analysis to elicit permit applicant preferences and mWTP. The fourth section introduces the survey methodology and model specification used, and the fifth section presents the empirical results. Lastly, the final section concludes the analysis and proposes future research recommendations.

MCNEIL RIVER BEAR VIEWING BACKGROUND

The McNeil River State Game Sanctuary (SGS) was established by the Alaska State Legislature in 1967 and was expanded in 1993. Along with the adjoining McNeil River State Game Refuge, the complex encompasses nearly 250,000 acres, supporting the protection of the largest concentration of wild brown bears found anywhere on earth [2]. Salmon runs in Alaska begin to peak in June, which is the major influence of the unique concentrations of brown bears in Southcentral Alaska. In the early and late periods of bear viewing season at the SGS, the most common bear activities viewed by visitors are digging for clams and foraging on vegetation, while fishing for salmon begins to pick up late June and begins to taper off beginning in early August. Unsurprisingly, the average number of bears viewed at McNeil River SGS peaks during mid-July, when the salmon runs are the most concentrated[2]. A record 74 bears have been viewed in one day at the SGS, and approximately 144 individual bears have been counted in one season [2].

Visitor access to McNeil River SGS is granted through an annual permit lottery administered by ADF&G, which requires an application fee of $30. The permit lottery was developed to provide the public with unique bear viewing opportunities while concurrently minimizing negative impacts to bears and the fragile ecosystem. Since the permit program was enacted, there has not been any reported human injury by bear, and no bears have been killed. In the last five years, there have been nearly 5,000 applicants to the permit lottery. Over this same period, bear viewing participants at McNeil River SGS have traveled to Alaska from 16 different countries around the world [17]. There are two types of non-transferable, 4-day Viewing Access Permits: Guided and Camp-Standby. Annually, 185 Guided Permits and 57 Camp-Standby Permits are issued. The permit lottery program limits the number of guided visitors to 10 individuals per 4-day time block between June 7 and August

[2] The 2017 season peak stock of 13,120 chum salmon located in the McNeil River Drainage occurred on July 12, indicated by the aerial survey escapement index [2].

25. When an applicant is drawn in the lottery, they are required to pay a permit fee, which varies by permit type and Alaska residency. Guided Viewing Access Permits guarantee a campsite and opportunity to view bears where they are likely to be most concentrated, with a professional wildlife guide, during the selected time block. Camp-Standby Permits guarantee a campsite and a placement on the Guided Viewing standby list. Should a visitor with a Guided Viewing Permit choose not to use their permit, a Camp-Standby permittee is offered the opportunity. It is exceptionally common for Camp-Standby permittees to see bears feeding on shellfish and vegetation along the coast, even if they are never granted access to join the Guided Viewing group of visitors [17]. There are twenty, 4-day permit time blocks that applicants choose between. Each applicant must specify up to four time blocks they wish to visit during. All permit blocks are subject to different odds of winning based on the number of applicants that choose the specific slot during the application process. Bear activity viewed is highly correlated with the type of food supply at the time of visit. The most preferred time for visitors is between late June and early August, based on the number of applications received for the corresponding time blocks. This is, not coincidentally, the same time range that salmon runs peak – see Figure 1, a photo of the iconic Alaskan bear viewing experience at McNeil River Falls. On average, there is about a two to five percent chance of winning a permit between June 23 and August 9. This clearly implies that permit applications are significantly driven by seasonality, attributed to the desire to see as many bears as possible, fishing for salmon, and hopefully cubs too. If an applicant wins the lottery for a Guided Viewing permit, they are required to pay an additional permit fee of $525 for non-residents and $225 for Alaska residents; if they win a Camp Standby permit, the cost is $262 and $112 for non-resident and Alaska resident, respectively [2].

In addition to the non-consumptive benefits that bear viewing visitors receive, there is also a financial advantage of the permit lottery system – McNeil River SGS is able to generate substantial revenues while minimizing human impacts.[3] Revenues generated through bear viewing lottery applications and permit fees help to fund McNeil River SGS operations and management. Between 2014 and 2018, the bear viewing permit lottery has generated an average of about $95,000 annually, which is deposited into the State of Alaska Fish and Game Fund [2].

FIGURE 1. McNeil River Falls, McNeil River State Game Sanctuary. Photo by: WikiMedia Commons/Drew H.

LITERATURE REVIEW

McNeil River State Game Sanctuary Visitor Welfare Estimations

Across the United States there are a multitude of wildlife-related lottery permit systems, but the majority of these lotteries are for consumptive use of wildlife opportunities, such as hunting and fishing (e.g. [9]).[4] Implementation, and applied research, of lottery permit systems for non-consumptive wildlife use, such as viewing and photography, are much less common. Two notable

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[3] Non-consumptive use of wildlife is defined as any activity of placing a value on or giving value to wildlife without removing the resource [15].

[4] Consumptive use of wildlife is defined as any activity whereby wildlife resources are exploited by removing a certain quota of fauna [15].

valuation studies focusing specifically on the McNeil River SGS permit lottery were published in 1988 [18] and 1993 [19], both of which collected data through use of on-site visitor surveys.

Hill (1988) [18] assessed visitor welfare associated with the McNeil River SGS permit lottery as a case study to highlight dissipation of economic rents associated with lottery mechanisms for distributing a good or service, as opposed to "market-like" mechanisms such as price. Hill's general assertion is that a visit to McNeil River SGS is a scarce economic good, and the current distribution mechanism (lottery) does not provide the highest societal benefits.[5] Hill (1988) [18] argues that one reason for considering a market-like alternative would be to raise revenues so as to cover the cost of the guided bear viewing program. Additionally, it may be in the interest of Alaska residents as State resource owners to maximize the return of this scarce resource by allowing the permits to be distributed in a way that minimizes economic losses.[6] The report subsequently presents economic impacts of the lottery mechanism estimated using a 1986 on-site survey of McNeil River SGS lottery participants.[7] A linear demand curve for Guided Viewing permits was derived from the collected data, which indicated that if bear viewing permits were sold or auctioned in some fashion, the "market" price would generate $464 per permit at minimum, and could even significantly exceed $696.[8] Based on these estimates, if the maximum 185 Guided Viewing permits were allocated and paid for, a conservative range of annual revenue could be from $85,840 to $128,760 [18].[9] Camp-Standby permits would then also generate additional revenues. Although the lottery mechanism is still used by ADF&G to distribute McNeil River SGS bear viewing permits, the agency most recently increased

[5] Scarcity is present when demand for a good is much higher than the limited supply of that good; e.g. there are not enough McNeil River SGS bear viewing permits to satisfy the overall demand for the permits. Therefore, a distribution mechanism (i.e. lottery, queue, price) is necessary [18].
[6] Economic losses discussed in Hill [18] include transaction (e.g. time) costs, non-transferability of permits, unused permits ("no shows"), and the societal losses resulting from permits not necessarily being used where they are valued the highest.
[7] 488 out of 806 surveys were returned (61% response rate) [18].
[8] Dollar figures adjusted from 1986 dollars to 2019 dollars using the BLS CPI Inflation Calculator accessed at: https://www.bls.gov/data/inflation_calculator.htm
[9] This range does not take into consideration additional permit fees collected from visitor transport authorizations or special access permits [18].

the fee schedule significantly in 2018 – all permit types increased by 50%. Revenues generated in 2018 from the permit lottery were approximately $96,060 – an increase of more than $22,000 from the prior year revenues of $73,400, even with 90 less permit applicants and 14 less payments received for all permit types [17]. Assuming all applicants would pay for the permit they apply for, we can discern that 872 individuals are willingly to pay, at minimum, the increased permit fees. This suggests that the total economic significance of bear viewing opportunities at McNeil River SGS is well beyond the direct revenues generated by the permit program [17].

Clayton & Mendelsohn [19] expanded the literature of visitor willingness-to-pay (WTP) for access to McNeil River SGS using the contingent valuation method (CVM). Four CV questions were asked in order to minimize wording-bias and confirm consistency among responses.[10] An on-site survey was administered in 1990 at McNeil River SGS, to approximately 90% of all visitors that year. The collected data was adjusted to eliminate protest bids of $0 and all responses in excess of $1,957, so not to allow outliers to skew the analysis (2019 dollars) [19]. The results were consistent with the predictions of Hill [17] – the average price visitors would be willing to pay is estimated to be about $490 per permit (2019 dollars). Echoing Hill, the authors suggest that increasing user fees has the potential to generate significant additional revenues [18]. Particularly, the survey data indicated that if there was a mixed-mode mechanism of distribution involving a guaranteed-permit auction in addition to the current lottery program, 20 guaranteed-permits would sell for about $980 each (2019 dollars), which would still allow for the vast majority of permits to be allocated by lottery [19]. Extrapolating these reported figures, revenues generated from the McNeil River SGS bear viewing permit program would hypothetically approximate $100,450, in addition to any Camp-Standby permit fees collected.[11]

[10] Two of the CV questions used to estimate the value of a McNeil River SGS visit were open-ended, direct WTP questions and two were presented in a discrete choice framework.

[11] 20 permits auctioned at $980 = $19,600 plus 165 (remaining) permits randomly distributed by lottery at $490 (the average WTP reported) = $80,850, totals $100,450

This figure lies directly mid-range of the estimates derived by Hill [18], and is slightly higher than last year's lottery permit program revenues of $96,060 [2].

Best-Worst Scaling (BWS) method

Best-Worst Scaling (BWS) is an umbrella term that can be broken out into three distinct cases: (1) best-worst object scaling, (2) best-worst profile (or attribute) scaling, and (3) best-worst multi-profile scaling (also known as best-worst discrete choice experiments [BWDCEs]) [8]. The BWS method of preference elicitation was first proposed in the early 1990s and the formal statistical properties were proven by Louviere and Marley in 2005 [16]. Louviere, Flynn, and Marley [5] define BWS as:

"an extension of the method of paired comparison to multiple choices that asks participants to choose both the most and the least attractive options or features from a set of choices". Problems arising from rating-scale techniques, such as with a Likert scale, are able to be avoided when using BWS for studying and modeling subjective consumer choice and preference due to the properties inherent of measurement in BWS analysis.

The BWS method has been found to produce the most robust and reliable data, allowing researchers to determine consumer preferences to the highest degree possible comparative to other possible methods. A notable reason for this is that respondents are able to fully comprehend each level in a BWDCE, in comparison to rating scales and ranking tasks which often involve vague scaling differences, causing asymmetrical interpretation among respondents [16]. The BWS method is derived from the basic economic assumption of random utility theory developed by McFadden in the 1970s [8] – "the BWS method effectively permits respondents to evaluate all pairwise combinations of alternatives presented in a particular subset leading to the assumption that their "best" and "worst" choices represent the maximum different in utility between all attributes" [16]. Following Lancsar et al (2017) [8], the general model for random utility assumes that respondent *r* derives utility *U* from choosing alternative *c* in choice scenario *s* is given by

$$(1) \qquad U_{rsc} = V_{rsc} + E_{rsc};\ r = 1, \dots, N;\ \ s = 1, \dots, S;\ \ c = 1, \dots, C;$$

where there are *N* respondents choosing from *C* alternatives across *S* scenarios. V_{rsc} represents the predictable element of overall utility of choosing alternative *c* and E_{rsc} represents the stochastic (random) disturbance unobservable by the analyst. Each discrete choice $y_{rs} = c$ is linked to associated utilities by assuming each respondent chooses alternative *c* when they stand to obtain the highest possible utility compared with any utility associated with the other individual alternatives in the choice set. The overall scale of utility is irrelevant in the sense that multiplying both V_{rsc} and E_{rsc} by any constant will express a different utility level but the resultant choice never changes. Thus, the scale of utility (i.e. E_{rsc} variance) must be normalized in order for econometric analysis to proceed, which is accomplished in many different ways depending on the chosen econometric model specification but in any case, requires a series of mathematical assumptions. In a traditional Multinomial Logit (MNL) model, stochastic disturbance is independently and identically distributed (iid). This aspect of the MNL model is extremely problematic when analyzing DCEs because it assumes proportional substitution across all alternatives regardless of actual data [8]. In the case of our chosen model specification Mixed Logit (MXL) (also referred to as Random Parameters Logit), the iid assumption is relaxed by introducing additional stochastic components to the utility function allowing for preference parameters to be heterogeneous and correlated over the sample [20]. In other words, variation of parameters based on individual preferences elicited is able to be further randomized "even after controlling for variation explained by observable characteristics" [8].[12]

[12] See the Model Specification section for further detail.

TABLE 1. McNeil River Bear Viewing Permit Lottery BWDCE Attributes & Attribute Levels

Attributes	Attribute Levels
Permit Application Price	$30 $55 $75 $100
Odds of Winning a Permit	3% 5% 8% 11%
Average Number of Bears Viewed Daily	15 30 45
Most Common Bear Activity Viewed	Foraging on Vegetation Digging for Clams Fishing for Salmon
Cubs Present	Yes No

BWS model specifications are analyzed using statistical software packages, such as Stata – the program used for the following empirical analysis. All three BWS cases require respondents to choose their most preferred (Best) and least preferred (Worst) object (as in case 1) or profile (as in cases 2 and 3) from a set of three or more options. Case 1 can be thought of as the least decomposed, where respondents choose their best and worst preferences between whole objects or statements without mention of any specific attribute levels. Case 3 asks respondents to choose their best and worst alternatives among multi-attribute profiles, while case 2 focuses on attribute levels within a single profile [8]. The following analysis of McNeil River SGS Lottery Permit Applicant preferences and WTP uses the multi-profile (case 3) BWDCE approach, in which each alternative option is composed of five attributes. Each attribute in our BWDCE profiles has a distinct number of levels, varying from two to four. Only those attributes that were deemed inherently significant to the Alaskan bear viewing experience were specifically chosen, which were further confirmed to be necessary to incorporate into the design following input from McNeil River SGS management.

STRUCTURE OF BEST-WORST DISCRETE CHOICE EXPERIMENTS (BWDCE)

Similar to traditional discrete choice experiments, BWDCEs present a series of profile alternatives for respondents to choose from [8]. Respondents choose their most preferred (Best) and least preferred (Worst) alternative profiles, each consisting of a distinct set of attributes with varying levels. BWDCEs may be designed to elicit the full spectrum of respondents' preferences by asking their sequentially preferred alternatives until an implied preference ordering is derived. At the very least, BWDCEs double preference observations at a low marginal cost to respondents, which typically increases statistical efficiency of empirical analysis. The number of repeated choices necessary from the respondent is dependent on a multitude of factors including, but not limited to: the number of attributes each alternative is composed of, the number of levels each distinct attribute consists of, interaction prohibitions/conditions, and standard error bounds. Our experimental design created with Sawtooth Software included 300 individual possible choice scenarios, from which each respondent was presented with eight tasks of three different scenarios to choose from. For purposes of internal validity, empirical analysis is typically considered robust when standard errors of .05 (5%) or below are reached [8]. In fact, the experimental design was tested within Sawtooth Software using the 'Test Design' feature in order to identify the number of respondents needed to ensure our model would produce statistically significant preference parameters.

Following Lanscar et al (2017) [8], key components of DCEs include: (1) discrete choices, (2) choice sets, (3) alternatives defined by attributes, (4) repeated measures, (5) respondent characteristics, and (6) context. Table 1 and Figure 2, both specific to our BWDCE, may be helpful to refer to as each component is described. (1) Discrete choices refer to the characteristic that respondents are faced with a choice set containing two or more mutually exclusive alternatives c during each choice task and are then required to evaluate these alternatives and select their most preferred (Best) and least preferred (Worst) alternatives. (2) Choice sets contain two or more alternatives which may be realistic hypotheticals as is the case in out BWDCE or may be real world alternatives that currently exist depending on the experiment – our BWDCE contains three alternatives. When 'no-choice' is not an option in the choice set the task is referred to as a forced choice problem, which helps to keep a realistic aspect in the sense that the point of the DCE is to overall preferences, even if that preference is the status quo. (3) Each alternative is defined by a set of attributes that are individually evaluated by respondents in order to come to a final decision about that alternative as a whole. Each attribute is broken out by levels which are randomized over choice tasks. Analysts may choose to incorporate prohibitions of attributes and/or attribute levels if they are implausible possibilities, which could skew or bias the data. (4) A panel structure is present in the data because each respondent is required to answer a sequence of different choice scenarios – our BWDCE presents eight choice scenarios for each respondent to answer. (5) As with nearly all surveys, personal characteristics such as sociodemographics are collected form respondents in a separate section from the choice scenarios. These data points can reveal the difference in value or utility amongst different respondents or groups of respondents, i.e. preference heterogeneity. (6) Choice context or environment significantly influences the realism of each hypothetical choice alternative [8].

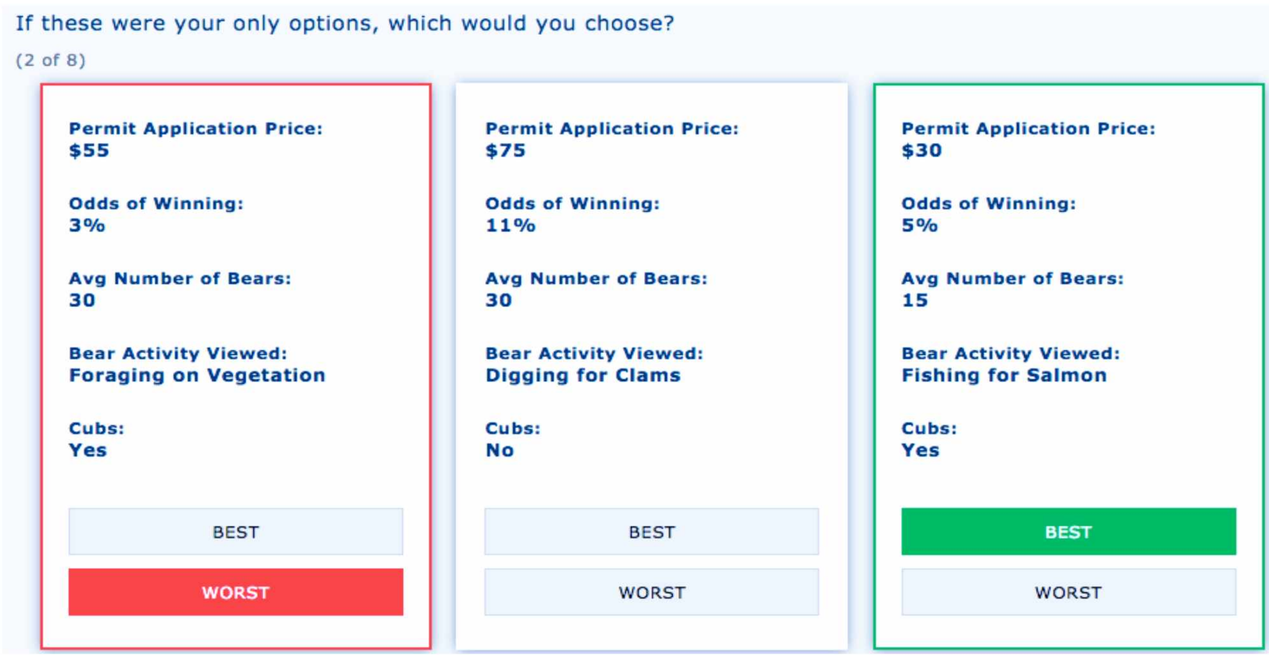

FIGURE 2. Example of Choice Set for McNeil River SGS Permit Lottery BWDCE

Our BWDCE clearly states that the unchanged context of the lottery permit program two separate times throughout the survey to ensure that each respondent is fully aware of these characteristics to be considered. Specifically, our BWDCE context was presented as following,

'You will be asked to evaluate 8 different randomized potential guided bear viewing trip alternatives. Each alternative represents a potential guided bear viewing trip to the McNeil River SGS. From each set of alternatives, you will be asked to identify your most preferred (BEST) alternative and your least preferred (WORST) alternative. Each alternative is made up of 5 characteristics:

(1) Permit Application Price: this value represents the cost to apply for the permit lottery. The current permit application price is $30.

(2) Your Odds of Winning a Permit: this value represents the likelihood of being drawn for a guided viewing permit.

(3) Average Number of Bears: this value represents the approximate number of bears you are likely to see each day.

(4) Common Bear Activity: this attribute identifies the type of bear feeding activity you are likely to observe.

(5) Cubs: this attribute indicates whether you do or do not see cubs on your trip.

Other considerations: The current permit fees (if you hypothetically were to be drawn for a permit) remain unchanged in all scenarios presented: $525 for non-residents and $225 for AK residents. There are also travel costs which depend on your origination point from AK.'

SURVEY METHODOLOGY

The Best-Worst Discrete Choice Experiment (BWDCE) method as described in the previous section is used to elicit McNeil River State Game Sanctuary (SGS) lottery permit applicants' preferences and marginal willingness-to-pay (mWTP) for specific brown bear viewing scenarios at the SGS. Although there are two distinct permit types, our survey only includes the Guided Viewing permit for the sake of minimizing necessary attributes to lessen respondent burden and understanding [17]. Additionally, Guided Viewing permits constitute more than three-quarters of all permits allocated annually and each one generates more than twice the amount of revenue compared to a Camp Standby permit.

Data collection was conducted through a web-based survey instrument designed and administered using Qualtrics and Sawtooth Software in June and July 2019. A pilot survey was also conducted in May 2019 in order to evaluate survey characteristics including response time, necessary question revisions, and overall survey clarification. The portion of the survey administered within Qualtrics included both qualitative and quantitative data relevant to the applicant's experience with the McNeil River SGS permit lottery program, general wildlife viewing activities, trips made to Southcentral Alaska for bear viewing (if applicable), and personal expenditures for those trips (if applicable). Respondents were solicited for their voluntary participation via postcard which provided a URL link for access online. The survey sample was chosen from the McNeil River SGS permit lottery records, obtained directly from ADF&G and included only applicants that entered the lottery between 2016 and 2018. Responses were received from 256 individuals, but analysis included only 224 for reason of significant data non-response, i.e. omission of BWDCE responses or sociodemographic data.

Sawtooth Software was used to conduct the BWDCE because of the experimental design capabilities embedded into the software. The Sawtooth experimental design used to construct choice scenario sets is referred to as the Balanced Incomplete Block Design (BIBD) [5]. BIBD is balanced in the sense that each profile or pair of profiles is equally likely to occur together in in different blocks or scenarios. 'Incomplete' refers to the fact that not all profiles are included in every block, due to the thousands of possible combinations of attributes and attribute levels [5]. Specifically, the BWDCE presents each respondent with an entirely randomized near-orthogonal, balanced subset of choice sets created from the full-choice design in an automatic balance overlap of attribute levels presented [6]. Using this approach reduces context bias and prevents inherent interactions among attributes present within fixed designs from causing systemic correlations, subsequently allowing for robust main effects and higher-order interaction estimations, given that a sufficiently large sample size is collected. One drawback of the randomized design is that heterogeneity of preferences and scale differences are indistinguishable from design heterogeneity during analysis, i.e. a form of heteroskedasticity may be present [6]. However, the experimental design includes 300 different choice scenario iterations within Sawtooth Software, which conveniently has the capability to structure the experimental design so as to correct for and therefore heteroskedasticity is not of concern. The design also allows us to incorporate one necessary restriction: 11% odds of winning and 45 average number bears viewed daily.

This restriction was implemented due to the reality that there are no 'peak' time blocks in which there is a possibility of 11% odds of winning, therefore it would be implausible to include as an option.

MODEL SPECIFICATION

Continuing our model specification discussion from the Best-Worst Scaling (BWS) Literature Review section, we now expand the mathematical framework on which the following analysis relies. For ease of understanding, the general model for random utility is repeated. Random utility theory assumes respondent *r* derives utility *U* from choosing alternative *c* in choice scenario *s* as given by

$$(1) \qquad U_{rsc} = V_{rsc} + E_{rsc};\ r = 1, \dots, N;\ \ s = 1, \dots, S;\ \ c = 1, \dots, C;$$

where there are *N* respondents choosing from *C* alternatives across *S* scenarios. V_{rsc} represents the predictable element of overall utility of choosing alternative *c* and E_{rsc} represents the stochastic (random) disturbance unobservable by the analyst. Each discrete choice $y_{rs} = c$ is linked to associated utilities by assuming each respondent chooses alternative *c* when they stand to obtain the highest possible utility compared with any utility associated with the other individual alternatives in the choice set. The MXL model assumes no scale heterogeneity and is normalized to unity designed to capture preference heterogeneity. Preference heterogeneity is assumed to follow a multivariate normal distribution. The iid assumption is then relaxed by introducing additional stochastic components, allowing preference parameters for explanatory variables to be correlated and heterogeneous amongst the sample data. This correlation allows for more flexible substitution between choices and enables us to capture dependence due to the panel structure because random variation around parameter means is considered fixed in choice scenarios yet varies among individuals [20, 22].

Following Train (2002) [21] and Holmes et al (2010) [20], the utility-maximizing respondent faces a choice among C alternatives and the MXL utility function of respondent *r* from alternative *c* is expressed as

$$(2) \qquad U_{rc} = \beta_r' X_{rc} + E_{rc}$$

where X_{rc} are observed variables related to the alternative and respondent, β_r is a vector of coefficients of these variables for respondent *r* representing that personal preferences, and E_{rc} is a random term that is iid extreme value. The coefficients β_r vary over respondents in the sample with density $f(\beta)$ which is a continuous function of parameters θ that represent, for example, the mean and covariance of the coefficients in the sample [22]. This specification is the same as for MNL except that β varies across respondents rather than being fixed. The probability that individual *i* chooses alternative *c* from choice set C is specified as

$$(3) \qquad P_{ir} = \int L_{ir}(\beta) f(\beta)\, d\beta \qquad \text{where}$$

$$(4) \qquad L_{ir}(\beta) = \frac{e^{V_{ic}(\beta)}}{\sum_{c=1}^{C} e^{V_{ic}(\beta)}}$$

and $V_{ic}(\beta)$ is the portion of utility observed by the analyst and dependent on the parameters β [20, 21]. The MXL model normalizes the scale of utility to unity and is designed to capture preference heterogeneity, allowing for $f(\beta)$ to possess a multivariate normal distribution. Additionally, MXL model assumes a combination of random and fixed variables [8].

The parameter estimate for price is treated as non-random in the results reported. All other variable parameter estimates are specified as random. We create dummy variables to identify respondents' preferences towards common bear activity viewed since they are not qualitatively defined – fishing for salmon is used as the base group against which comparisons are made.

Marginal Willingness-to-Pay (WTP) measures is a meaningful and convenient way to compare attribute estimates and, following Lancsar et al (2010) [8], are derived as the marginal rate of substitution (MRS) between attribute $X^z$and price (P) expressed as

$$(5) \qquad mWTP_{X^z} = -\frac{MU_{X^z}}{MU_P}$$

where MU_{X^z} and MU_P are the marginal utilities of attribute X^z and price, respectively. We specify each utility function to be linear in parameters so as to assume the marginal utility of an attribute is equal to its coefficient. Using the Stata direct estimation of mWTP in willingness-to-pay space avoids complications that can arise from specific model specification characteristics. When an analyst chooses a distribution for the price coefficient which is constrained to be negative it must then be constrained to be lognormally distributed so that it does not cross zero, i.e. is always negative. If this is not specified, the price coefficient becomes infinite and therefore undefined [8].

EMPIRICAL RESULTS

The survey captured a broad sample of lottery permit applicants in that responses were received from residents of 31 states in addition to Alaska. As shown in Table 2, the majority of respondent's (68%) indicated that they had been awarded a permit to McNeil River SGS, and 134 of those 152 have visited. One respondent even noted that they had visited five separate times. For those that have visited the SGS, 48 indicated that their most recent visit was in June, 51 in July, and 30 in August. More than 70% of respondents traveled to McNeil River SGS from Homer, Alaska and 20% from Anchorage. Of all respondent's in the sample only 24% are aged 50 or below, 62% are between 50 and 70 years of age, and remaining 14% are older than 70 years.

TABLE 2. Characteristics of Respondents

Variable	Description	Mean	S.D.	Mode
Age	Respondent's Age	58.32	12.06	60, 64
Education	Highest level of education completed by respondent: 1= high school graduate/GED, 2= trade/technical/vocational training, 3= Associate's degree or some college, 4= Bachelor's degree, 5= advanced degree (e.g. MS, JD, PhD)	4.18	1.03	5
Employment	Respondent's Employment Status: 1= Employed, full-time; 2= Employed, part-time; 3= Retired; 4= Student; 5= Unemployed; 6= Disabled	1.96	1.02	1
Income	Personal annual income level (if retired, respondent's income during last year of employment): 1= Less than $25,000; 2= $25,000 to $49,999; 3= $50,000 to $74,999; 4= $75,000 to $99,999; 5= $100,000 to $124,999; 6= $125,000 to $200,000; 7= More than $200,000	4.48	1.72	4
Residency	Dummy variable: 0 if Alaska Resident, 1 if non-resident	0.53	0.50	1
Permit	Dummy variable: 0 if respondent has never won the permit lottery, 1 if the respondent has won the permit lottery	0.68	0.47	1

Nearly 50% (108 of 224) respondents indicated their highest level of education to be an advanced degree such as a PhD, MD, MA, MS, JD, or MBA. Exactly 50% of respondents indicated that they are currently employed full-time and another 41% retired. Personal income was evenly spread out with each category of income level ranging between 15% and 20%, except only 3% in the lowest bracket of less than $25,000. Additionally, 108 (49%) individuals indicated making $100,000 or more annually. Respondent residency was split 53/47, Alaska resident/non-resident.

Logit Model Results

The Stata command mixlogit fits mixed logit models by using maximum simulated likelihood [21]. The dependent variable is *rankchoice*, the only non-random independent variable is permit application price, and all other independent variables are considered random. All random independent variables by default have normally distributed coefficients $ln(0)$. The base group of the dummy variables indicating 'most common type of bear feeding activity viewed' is 'fishing for salmon'. Detailed variable descriptions are shown in Table 3.

Following Holmes et al (2010) [20], 500 Halton draws from the normal distribution are used for simulation. The default Halton draws in Stata is n(50) – as the number of draws increases, differences between estimated means and true means become smaller. Halton draws are defined as quasi-random numbers, and are evenly spread over the integration domain, which are used as an alternative to pseudo-random numbers in maximum simulated likelihood problems. The choice probability in the MXL model cannot be precisely calculated because it involves a multi-dimensional integral which does not have closed form. The use of pseudo-random numbers to approximate the integral during simulation leads to long computational times, so instead pseudo-random numbers are replaced by a set of fewer, evenly spaced points (Halton draws). Halton draws have been proven to achieve the same estimation accuracy, if not even higher accuracy as discussed by Zeng (2016) [23]. Results of the MXL model are shown in Table 4, along with results from running Multinomial Logit (MNL) and Conditional Logit (CL). MNL and CL results were estimated in order to check that that use of MXL, i.e. random parameters, is in fact more robust.

TABLE 3. Variable Descriptions

Variable	Description	Mean	S.D.
Rankchoice	Respondent's choice alternative ranking: 1= Best, 0= Worst	-	-
Price	Permit Application Price: \$30, \$55, \$75, \$100 (approx. \$25 increments)	65.03	25.75
Mprice	Price multiplied by -1	-	-
Odds	Likely odds of winning a permit: 3%, 5%, 8%, 11% (approx. 3% increments)	7.97	2.11
Numbears	Average number of bears likely to be viewed daily during visit to McNeil River SGS: 15, 30, 45	29.89	12.23
cubs	Dummy variable: 1 indicates cubs will be present during visit to McNeil River SGS, 0 if cubs are not present	-	-
Fish	Dummy variable: 1 indicates the most common type of bear feeding activity viewed during visit to McNeil River SGS is fishing for salmon, 0 if not	-	-
Dig	Dummy variable: 1 indicates the most common type of bear feeding activity viewed during visit to McNeil River SGS is digging for clams, 0 if not	-	-
forage	Dummy variable: 1 indicates the most common type of bear feeding activity viewed during visit to McNeil River SGS is foraging on vegetation, 0 if not	-	-

Additionally, the MXL model was run with uncorrelated parameters, and again assuming correlated parameters. A joint significant test using the Chi-squared statistic equal to 388.57 is given in the output, implying that the null hypothesis of uncorrelated parameters can be strongly rejected, i.e. the parameters, are in fact correlated. To verify results of the MNL and CL models, they were run with the 'most common bear feeding activity viewed' variable as dummy variables, and then again with them taking a categorical specification. As shown in Table 4, both models estimated the exact same preference parameters indicating that the type of variable does not change the output. All variables in the table are statistically significant at the 1% level.

TABLE 4. Mean Preference Parameter Estimates for a Guided Viewing Permit Dependent on Attributes Associated with Bear Viewing at McNeil River State Game Sanctuary

Variable	MXL Dummy (std. error)	MXL corr Dummy (std. error)	MNL Dummy (std. error)	MNL Cat. (std. error)	CL Dummy (std. error)	CL Cat. (std. error)
Price	-0.016 (0.002)	-0.016 (0.002)	-0.010 (0.001)	-0.010 (0.001)	-0.009 (0.001)	-0.009 (0.001)
Odds	0.387 (0.033)	0.386 (0.034)	0.241 (0.012)	0.241 (0.012)	0.234 (0.013)	0.234 (0.013)
Numbears	0.059 (0.006)	0.064 (0.007)	0.039 (0.003)	0.039 (0.003)	0.036 (0.003)	0.036 (0.003)
cubs	1.671 (0.149)	1.662 (0.157)	1.139 (0.067)	1.139 (0.067)	0.965 (0.064)	0.965 (0.064)
Fish	Basegroup					
Dig	-1.944 (0.165)	-1.954 (0.198)	1.495 (0.081)	1.495 (0.081)	1.265 (0.077)	1.265 (0.077)
forage	-2.180 (0.182)	-2.177 (0.220)	0.096 (0.084)	0.096 (0.084)	0.082 (0.080)	0.082 (0.080)
N	224 respondents (5,376 total observations in each model)					
Log Likelihood	-1260.488	-1253.624	-2810.128	-2810.128	-1447.9089	-1447.909

As expected, the parameter estimates on the permit application price, foraging for vegetation, and digging for clams are negative. However, the magnitude of *price* indicates that respondents do not seem to be price sensitive, and this may be true for two different reasons. First, as Table 2 indicates, respondents' personal annual income averages about $100,000. Additionally, the majority of respondents may view the permit application price to be a donation towards conservation of the bears' habitat which could imply that the increase in price is not necessarily a deterrent of current or future application. Standard deviations are present in the MXL model output and statistically significant at the 1% level (not shown), indicating that the estimates are heterogeneous across the sample – another indication that the MXL model offers more robust estimates for the data as opposed to the MNL or CL models which both assume fixed parameters. The negative parameters on *forage* and *dig* variables were expected to be negative because bears fishing for salmon is the quintessential aspect of the Alaskan bear viewing experience. More specifically, bears are typically seen fishing for salmon at small waterfalls, such as McNeil River Falls and Mikfik Creek Falls at the SGS [2], or Brooks Falls in Katmai NP&P [3] (see Figure 2). The rest of the random variables (*odds, numbears*, and *cubs*) are all estimated to have a positive impact on utility as indicated by the positive coefficients. Whether or not cubs are present, in particular, is estimated to have quite a significant impact. The average number of bears viewed daily at the Sanctuary is positive, but not large in magnitude. This could be interpreted to mean that most people are in awe of seeing even just 15 bears all in the same place, feeding right next to one another. Bears are extremely territorial is this phenomenon is typically not seen anywhere else in the world, but the abundant food supply in the region has allowed bears to be tolerant of each other. However, the model does still indicate utility increases slightly as more bears are present.

Marginal Willingness-to-Pay (mWTP) Estimates

The Stata command mixlogitwtp is a type of postestimation that conveniently fits mixed logit models in willingness-to-pay (WTP)-space by using maximum simulated likelihood [21]. We again use 500 Halton draws from the normal distribution for simulation in order to obtain estimate means as close as possible to the true mean. Results of the mWTP estimates is reported in Table 5. The *price* coefficient in the MXL model is, by default, lognormally distributed, implying that price is therefore positive so in order to estimate mWTP the price variable is multiplied by -1 to create *mprice*. The price coefficient in WTP space incorporates all differences in scale across respondents [8].

Marginal WTP measures are much more intuitive and easier to interpret in a real sense than the preference parameters because mWTP estimates are directly measured monetarily. According to our mWTP estimates, an individual is willing to pay an additional $23.42 for every 3% increase in odds of winning a permit. An increase of about 15 bears viewed during an average day at McNeil River SGS is not as important of a factor to the sample respondents, indicating a mWTP of only $3.50. Additionally, our estimates indicate that an individual would pay an astounding $103.41 to see bear cubs while at McNeil River SGS. Perhaps even more interesting is we estimate that an individual is WTP a whopping $136.44 and $122.71 in order to guarantee viewing the bears fishing for salmon over foraging for vegetation and digging for clams, respectively.

TABLE 5. Estimates of Marginal Willingness-to-Pay (mWTP) for Lottery Permit Application Dependent on Incremental Increase of Attributes Associated with Bear Viewing at McNeil River State Game Sanctuary

Variable	Mean estimate (std. error)	95% Confidence Interval
Price	-0.019*** (0.003)	[-0.024, -0.013]
Odds	23.415*** (3.182)	[17.179, 29.652]
Numbears	3.497*** (0.528)	[2.462, 4.531]
cubs	103.414*** (13.700)	[76.561, 130.266]
Fish	Basegroup	
Dig	-122.707*** (15.977)	[-154.020, -91.393]
forage	-136.441*** (17.878)	[-171.481, -101.401]
N	224 respondents (5,376 total observations in model)	
Log Likelihood	-1285.549	
*** denotes significance at the 0.01 level ** denotes significance level of 0.05		

Bears fishing for salmon in large concentrations is the iconic bear activity that is associated with coastal brown bear viewing in Alaska, which is unique to the region on a worldwide scale. This feeding activity combined with the sheer number of bears (sometimes upwards of 50 bears at a time) side-by-side feeding together is extremely rare in the sense that bears are highly territorial and typically do not share feeding grounds with other bears. In comparison, is it fairly likely for visitors to see bears foraging or digging for food in other areas of the world including Yellowstone National Park & Preserve, Denali National Park & Preserve, and many other global bear-viewing sites in Russia, Finland, etc [24].

CONCLUSIONS

The use of economic surveys, and BWDCEs in particular, are a powerful tool for estimating utilities and a multitude of interesting postestimations such as marginal willingness-to-pay (mWTP). In this study, McNeil River SGS lottery permit applicants were elicited for a web-based survey in order to estimate bear viewing attribute preferences and mWTP for incremental increases of each attribute. The Mixed (Random Paramters) Logit (MXL) is chosen to model our data so that we can allow the parameters to be random, i.e. its capability to relax the iid assumption which allows for preference parameters to differ amongst respondents so as to model reality more closely, acknowledging that respondents have heterogeneous preferences [8, 22].

A BWDCE was presented to respondents using eight choice tasks, giving the data a panel formation. Each choice task was comprised of three different choice scenarios, which individually contained five attributes: permit application price, odds of winning a permit, average number of bears viewed daily at McNeil River SGS, whether cubs were present or not, and the most common type of bear feeding activity viewed daily at McNeil River SGS. Between two and four levels per attribute were presented amongst the different choice scenarios shown.

The analysis revealed that on average, respondents are willing to pay a substantial premium well beyond $100 to see cubs, and between approximately $122 and $136 in order to view bears fishing for salmon rather than digging for clams or foraging on vegetation. These findings are related to previous studies published in the late 1980's [18] and 1990's [19] of welfare estimates associated with the permit lottery distribution mechanism at McNeil River SGS. In particular, this analysis reiterates that permit lottery applicants are more than willing to pay above and beyond the current visitation fees. If these increases were to be enacted, revenues would potentially be able to cover the entire cost of operating McNeil River SGS, which is currently not the case. It is also worth noting that the price of the permit application did not much deter applicants solely, but rather the bear viewing experience was seemingly impacted much more by increased odds of actually winning, seeing bear cubs, and being able to watch the bears fish.

Consequently, our results suggest that increases in permit fees for specific seasonal attributes such as cubs being present or having the ability to view bears during the iconic occurrence when high concentrations of bears gather to fish for salmon concurrently. However, it is possible that our sample size of 224 does not fully represent all lottery permit applicants considering the survey was entirely voluntary and only solicited to those who applied to the lottery between 2016 and 2018. Therefore, it would be in the interest of McNeil River State Game Sanctuary Management, Alaska Department of Fish & Game, and the 'owners' of the resource (residents of Alaska) to repeat similar analysis every so often to reestablish the baseline and ensure that management of McNeil River SGS are maintaining a positive experience for lottery permit applicants and visitors alike. Additionally, it may be worth it in future research to include more detailed analysis relating to the perception of the 'iconic' McNeil River SGS bear viewing experience of watching the bears fish for salmon in large concentrations, side-by-side.

APPENDIX

IRB Approval Letter:

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Institutional Review Board

909 N Koyukuk Dr. Suite 212, P.O. Box 757270, Fairbanks, Alaska 99775-7270

March 25, 2019

To:	Joe Little Principal Investigator
From:	University of Alaska Fairbanks IRB
Re:	[1400529-1] Alaska Brown Bear Viewing Visitor Study

Thank you for submitting the New Project referenced below. The submission was handled by Exempt Review. The Office of Research Integrity has determined that the proposed research qualifies for exemption from the requirements of 45 CFR 46. This exemption does not waive the researchers' responsibility to adhere to basic ethical principles for the responsible conduct of research and discipline specific professional standards.

Title:	Alaska Brown Bear Viewing Visitor Study
Received:	March 18, 2019
Exemption Category:	*2*
Effective Date:	March 25, 2019

This action is included on the April 3, 2019 IRB Agenda.

Prior to making substantive changes to the scope of research, research tools, or personnel involved on the project, please contact the Office of Research Integrity to determine whether or not additional review is required. Additional review is not required for small editorial changes to improve the clarity or readability of the research tools or other documents.

America's Arctic University

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